Avionics Software Challenges and Initiatives

Briefing to Software Design and Productivity Workshop
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Avionics Software Situation

Software has become the pacing element in the development and modernization of military avionics systems

- **Accounts for a growing percentage of system complexity and cost**
- **Increasing instances of cost/schedule overruns**
- **More errors slipping through to fielded systems**

The Challenge: Provide affordable, maintainable, high-integrity software within budget and delivery constraints

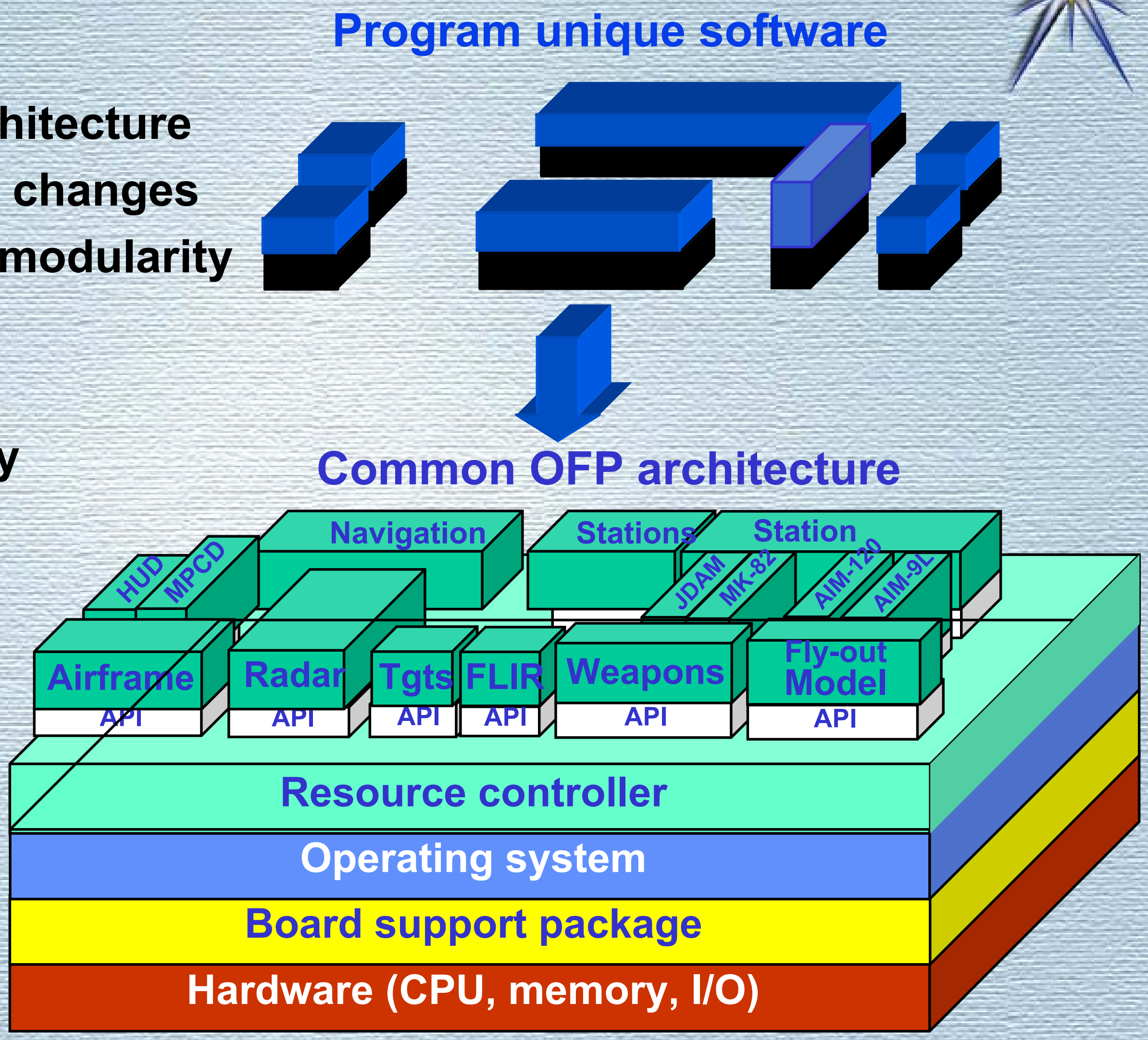
Problem Statement

- Technology trends in weapon systems are driving exponential growth in software complexity
  - Autonomous systems, adaptive systems, fault-tolerant systems…
- Traditional approaches and processes do not scale well
  - Program-specific architectures, languages, tools
  - Unaligned with commercial practices
- High turnover in defense software workforce
  - Ad-hoc knowledge management for legacy systems
  - Constantly climbing the learning curve

Current technology, practices and culture of the industry cannot cope with the emerging environment

Product Line Software Architecture

- Hierarchical layered architecture
- Isolation from hardware changes
- Plug-and-play software modularity
- Reuse applications
- Change encapsulation
- Improved maintainability
- Improved productivity



Program unique software

Common OFP architecture

Application software {

Infrastructure (COTS) {

Hardware (COTS) {

Where are the Technology Voids?

COTS supports some aspects of development well, but many voids exist:

- "Front end" of process
  - Model-based tools for requirements/design capture
  - Automated configuration and integration of components
- "Back end" of process
  - Simulation-based testing
  - Formal verification methods and tools
- Support for hard real-time, embedded systems is limited
  - Quality-of-service requirements expression/guarantees
- Support for high-dependability systems is limited
- Legacy system constraints
  - Infusing new technology into resource-limited, "closed" systems

Cultural Challenges

- Defense acquisition culture presents impediments
  - “Silo” approach to planning/funding system modernization
  - “Wasn’t invented here” mindset in programs
  - Inability to trade front-end investment for life-cycle returns, even when business case is compelling
  - Support structure based on single fielded configuration
  - T&E community resistance to tailored re-qualification
- FAA software development/verification culture presents aditional impediments
  - Approved processes lag technology
  - “Cradle to grave” involvement and oversight
- Synergy with COTS industry will always be limited without cultural transformation

Summary

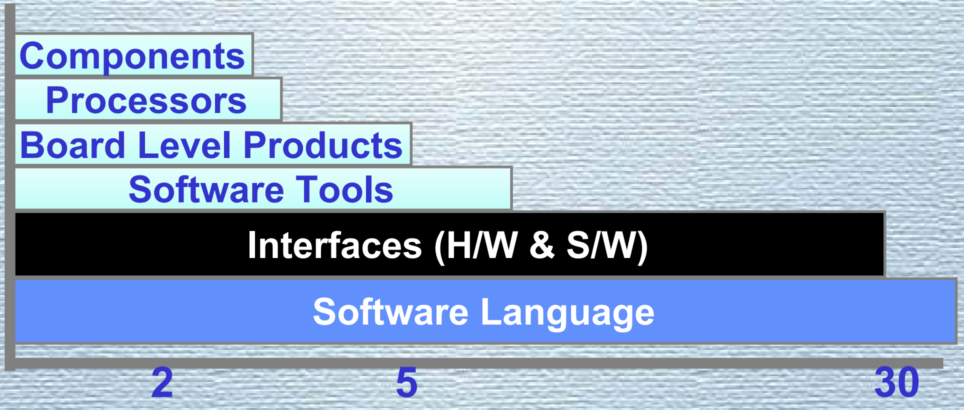
- Boeing remains fully committed to a product line strategy for avionics software
  - Founded in COTS, open systems architecture
  - Large, multi-year IRAD investment
  - Growing number of platforms
- Government/industry partnership is needed to realize th efull potential
  - Complementary investments in technology
  - Acquisition reform
  - FAA/certification authority involvement

Back Up

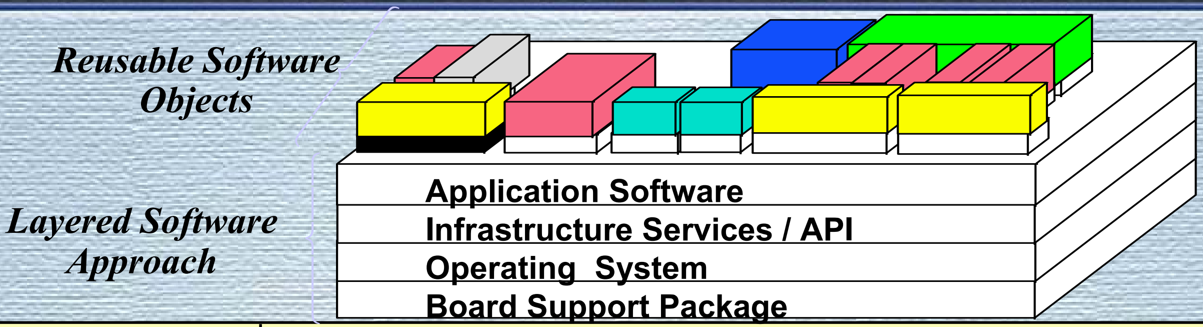
Leveraging COTS

- To leverage COTS technology, military system developers must establish boundaries of stability
  - System functionality must remain stable for many years
  - Changes forced by obsolescence must be contained
    - > Re-qualification is too expensive to do often
  - Sources of COTS are not under configuration control

Time to Obsolescence (Years)



COTS Leverage - Run Time


Reusable Software Objects
Layered Software Approach
Application Software
Infrastructure Services / API
Operating System
Board Support Package

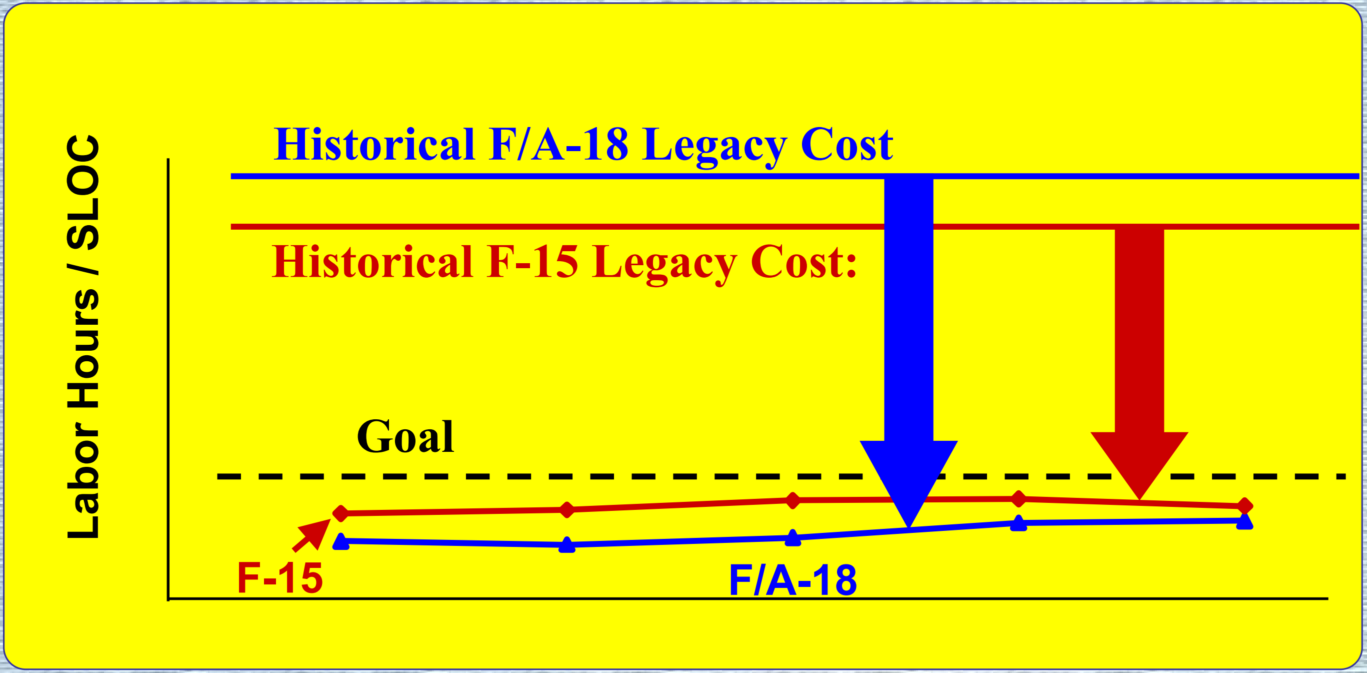
Item	Description
Board Support Package	• Tailors the OS for Hardware Platform • COTS Software (VME Drivers, Interrupt Handlers)
Operating System	• COTS Real Time Operating System (e.g. VxWorks from Wind River) • POSIX Compliant Run Time Environment
Infrastructure Services / API	• Common Object Request Broker Architecture (CORBA) Compliant Infrastructure • Facilitates Distributed Object Oriented Computing and Communication
Application Software	• Object Oriented Design Methodology • Written in C++/Ada High Order Languages • Contains Reusable S/W "Building Blocks"

COTS Leverage - Development Tools

Item	Description
Requirements Analysis and Management	• DOORS® Toolset for Requirements Capture
Software Development	• Rational Rose® Toolset for Object Oriented Analysis / Design • Microsoft Visual C++ for Program/Debug
Auto Code Generation	• VAPS® Toolset for Open GL Prototype Display Code Generation • Rational Rose Tool for C++ Code Generation
Desktop Test Environment (DTE)	• Facilitates Early Testing of S/W Components • Reduces Requirements for S/W Test Benches • Contains Microsoft Visual C++ Code Debugger • COTS Graphical User Interface Developer • VAPS® Display Simulation • Common Test Language • C++ Aircraft/Avionics Simulation
Configuration Management	• ClearCase / ClearQuest

Early Returns - Measured Benefit

Cumulative Software Development Productivity



Key Sources of Gain:

- Reuse
- COTS Tools
- Change Containment
- Desktop Testing

Demonstrated Software Development Cost Reduction to less than 25% of Legacy Programs

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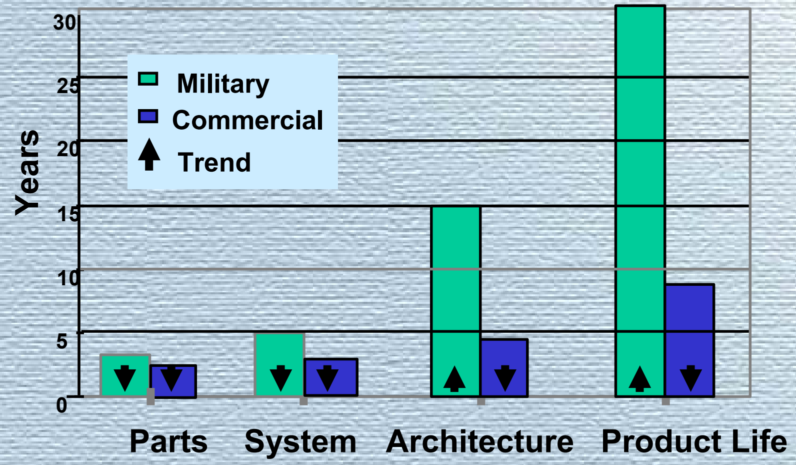
Where to Look First - the Commercial Sector

COTS market appears to be getting the job done, but:

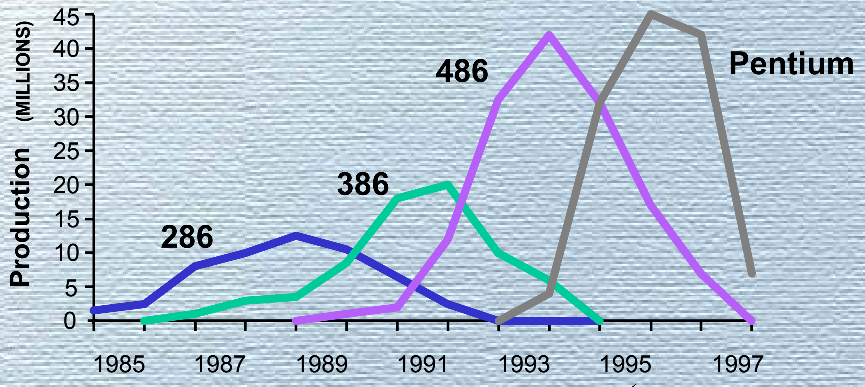
- System turnover rates are much higher
- Systems are fielded with bugs
- Deadline-driven culture vs. “getting it exactly right” culture
- Systems are not as capacity-limited

Inherently greater leverage of automation and re-use

Product Cycle - Military Vs Commercial



Product Lifetimes are getting Shorter



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